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The general discussion of each subclass is followed by a key to its orders, and of each order by a key to its families. These keys are clear and simple, and add greatly to the value of the book. After each special topic, or discussion of a family, a bibliography is appended, in which the selection of the titles has been dictated by matured judgment. The illustrations are numerous and appropriate. Many of them are crudely drawn, which detracts greatly from the appearance of the book, but they are always clear and accurate. Much consideration is given to the cytological aspect, which in view of the research interests of the author is not surprising. The frequency with which she emphasizes the points in need of further cytological investigation should prove stimulating to workers in this field.

The implication on page 47 that we must accept two nuclear fusions as the normal situation in all Ascomycetes will be regarded by many mycologists as premature. The entire subject must be carefully reinvestigated in the light of recent parallel studies on the Basidiomycetes before this can be regarded as definitely established. In this connection, the reference to clamp connections as structures which have no significance other than to facilitate the passage of food (p. 1), and as merely vegetative phenomena (p. 188), will have to be revised. Again, the statement that "in *Puccinia*, *Phragmidium*, and other Uredinales . . . the basidia are developed in chains" seems to stress unduly the cytological conception of the basidium, just as the thought of each cell of the promycelium as a one-spored basidium, as held by other botanists, seems to place undue emphasis on morphological detail. Lacking more convincing evidence than has yet been presented, it would seem better to retain the intermediate and generally accepted view that the teleutospore cell is not a basidium, but is the cell that gives rise to one, either externally, as a promycelium, or internally. In fact, the author is not consistent in her treatment, and seems to recognize the latter view on the same pages on which she gives different interpretations.

The proofreading has been carefully done and typographical errors are few. Fig. 27*e* is a transverse, not a longitudinal section, and a few words, mainly proper names, are misspelled, all of very minor importance. The author is to be congratulated on the effective presentation of a mass of information which has heretofore been scattered and largely inaccessible to the majority of the workers in this field. She has performed an invaluable service in collating this work and in presenting it so clearly and concisely. The book is a necessity for the reference shelf of every laboratory where mycology is taught.—G. W. MARTIN.

Lichens

MISS ANNIE L. SMITH,² of the British Museum, is the author of a notable work on lichens, in which are considered the history of lichenology, the morphol-

² SMITH, ANNIE L., Lichens. 8vo. pp. xxvii+464. *figs.* 165. Cambridge University Press, England. 1921.

ogy of the lichen thallus, reproduction in lichens, and the physiology, bionomics, phylogeny, taxonomy, ecology, and economics of lichens.

The history of lichenology is treated in seven chapters, six of which follow KREMPELHUBER in the first volume of his *Geschichte und Litteratur der Lichenologie*. The seventh period extends from 1867 to the present time. Very wisely, little space is devoted to the first six periods, as much of the work of these periods was based on a wholly wrong conception of lichens, and the systematic treatment was largely very poor. In 1867 and the following year DEBARY and SCHWENDENER established the fact that what had been considered constituent parts of lichens were algae, with which the lichens were growing in symbiotic relationship, and made modern lichenology possible. For the six periods, those especially interested can refer to KREMPELHUBER's extended treatment; but it would seem that the seventh period, which covers all of modern lichenology, might well have received more space.

Preceding the discussion of morphology proper is a chapter in which the algal host cells are treated as constituents of the lichen, under the term "gonidia," which designation, according to the belief of many botanists, should have been consigned to oblivion long since. The treatment of the relationship between the lichen and its algal host contains much information that is valuable, but unfortunately it is all based on the supposition that the lichen is a composite structure, a fungus and many individual algae, and still in some mysterious way a plant. It is the belief of a constantly increasing number of American botanists that such a confusing presentation should never be placed before the student or the botanist.

In the treatment of types of thalli, structures peculiar to lichens, cells and cell products, general nutrition, assimilation and respiration, illumination, and color, the chapters on morphology and physiology carry much that is valuable. All is colored by a phraseology which is confusing to those who believe that lichens are fungi, however, and indeed scarcely comprehensible to them, excepting a few of the older ones, who, like the reviewer, were taught to believe that the lichen should be considered both a colony and an individual.

The chapter on reproduction on the whole is excellent, and is perhaps the most up-to-date and valuable portion of the volume. The discussion takes form under such topics as types of fruits, development of reproductive organs, apogamous reproduction, stages of apothecial development, and spores and asci. The treatment of forms of reproductive organs in lichens is the first adequate presentation to appear in a text. For those of us who believe that lichens are fungi which should be treated like other fungi, and that carpologic development and structure should play a large part in taxonomic disposition, this chapter brings our data together in convenient form so far as lichens are concerned. Unfortunately, the discussion of the matter in other Ascomycetes is given separately toward the close of the chapter.

Rather closely related to the consideration of reproduction stands that of phylogeny in another chapter. This opens with a presentation regarding the algal hosts, which many would omit from a consideration of the phylogeny of lichens. Following this is a valuable treatment of the relationships between lichens and other fungi from the standpoint of evolution. The evolution of the thallus is considered next, then that of the various groups of lichens. The chapter closes with a "scheme of suggested progression in lichen structure."

The chapter on taxonomy considers first the various schemes of arrangement, following which the lichens are arranged according to the system of ZAHLBRUCKNER, as given in ENGLER and PRANTL. Then follow treatments of number and distribution of lichens, with a survey of the lichens of polar and temperate regions, and fossil lichens. Probably ZAHLBRUCKNER would modify the classification outlined fifteen years ago considerably, were he to give his present views; but it is readily conceded that no lichenist, save perhaps WAINIO, has shown so much skill and knowledge in the classification of lichens. For one who believes that lichens are dual organisms, there is no other possibility than to consider them a distinct group of plants, as is done in the volume before us. Also, as a matter of expediency, lichens may be treated separately by those who believe that they are fungi, although at the expense of failing to present adequately the many close relationships between lichens and other fungi. In any flora which covers all fungi, distribution should be made somewhat as is done in papers by the reviewer and several other American botanists.

The chapter on bionomics contains a valuable discussion of the growth and duration of lichens, the season of fruit formation, dispersal and increase, parasitism, and the diseases of lichens. Closely related to this is the chapter on ecology, which brings together for the first time a considerable portion of the material which deals with this subject. Although the research on lichen ecology is mainly pioneer work and much of it faulty, the worker in this phase of ecology must refer to the chapter, which will be bewildering to many who have concluded that lichens are fungi.

While SCHWENDENER and other Europeans have held that lichens are fungi, they have not been able to treat lichens as fungi after the method of mycology in general. This has been left to America, where the more rational treatment of these plants began to take form a generation ago and is now taught in a considerable number of institutions and believed by many teachers and other botanists. The reviewer does not relish attacking the conception of lichens held by the author of a work of great merit. The issue is unavoidable, however, and although American botanists may get much of value from the volume, it is to be hoped that students will not be taught that lichens are not plants, but yet in some mysterious way are plants, and that maturer botanists may be able to get that which is valuable from the work and not fall into the confusing phraseology regarding the nature of lichens.—BRUCE FINK.